

Boston Univ 7  
1958  
1104  
Annual Technical Report<sup>1</sup>

Principal Investigator: Warren G. Bennis<sup>2</sup>  
Massachusetts Institute of Technology

Project Director: Arthur M. Cohen  
Boston University

Research Assistant: George H. Wolkon  
Boston University

The results of two studies are contained in this report in summary form.<sup>3</sup> They represent the first parts of a program of research designed to study the effects of change and history on the behaviors of problem-solving groups. Perhaps the most unsatisfying aspects of experimentally studying problem-solving groups lies in the fact that results too frequently represent observations made in assumed steady state and in a single slice of time. In many ways, mostly based on intuition and personal experience, credence is given to the suggestion that the past experiences of a group or organization affect behavior: the selection of goals, the procedures adopted to reach such goals, and other kinds of important decisions. However, neither an adequate theory nor an adequate empirical base for deriving propositions which can successfully represent the connections between past events and present ones is available. The studies reported here comprise the first

1. This report is based on research sponsored by the Office of Naval Research, Group Psychology Branch, under Contract Nonr 492 (05), Task No. NR 170-255. The research was conducted at the Human Relations Center of Boston University.

2. Dr. Bennis was at the Human Relations Center of Boston University at the time this research was conducted.

3. Complete details will be given in the final technical reports representing the results of this research.

**DISTRIBUTION STATEMENT A**  
**Approved for Public Release**  
**Distribution Unlimited**

19990714 148

stage in an exploratory effort to develop a general form for understanding the effects of past experience and change on the behaviors of problem-solving groups. The first study involved the effects of continued practice on the behaviors of problem-solving groups. Groups, in two kinds of communication patterns, solved many more problems than in previous studies. The purpose of the first study was to obtain adequate estimates of learning curves, determine the points most appropriate to introduce change and provide a partial replication of the initial Leavitt study (10). The second study, utilizing the information about learning curves obtained in the first study, investigated the effects on behaviors when changes were made in the communication patterns which defined the work arrangements of problem-solving groups. The relative effects of different antecedent conditions were studied. With the exception of the imposed changes in networks, the procedures, apparatus, number of groups in each condition, number of trials and other parts of the experimental environment were the same in both studies.

### Study I

#### The Effects of Continued Practice on the Behaviors of Problem-solving Groups

This study was concerned with the effects of continued practice on the behaviors of problem-solving groups. Ten groups of five subjects each were assigned to each of two experimental conditions: (a) the Wheel and (b) the Circle. A Wheel pattern was considered more structured and hierarchical. In this pattern each of four members could communicate to the fifth, but to no one else. The fifth person could communicate to everyone directly. The others had to go through him if they wanted to communicate to someone else. These four members were equal to each other in the communication restrictions

imposed on them, but they were much more restricted than the fifth member. The Circle pattern contrasted sharply with the Wheel. In it every member had equal communication opportunities. Each could communicate directly with the persons to his immediate right and left. In addition to the fact that all members in the Circle pattern had identical restrictions, it was apparent that the Circle was a less restricted condition as it had more channels open for problem-solving.

Each group tried to solve a total of sixty problems consecutively. Questionnaires were administered after each set of five trials. These measured: certainty of answers, satisfactions with job, other members, the task and perception of leadership. The task used, as well as the other experimental conditions, were intended to approximate as much as possible the conditions of the original Leavitt experiment (10), with the exception of using considerably longer working periods.

The kinds of differences between Wheel and Circle networks that were found were: Wheels took shorter times, had more correct trials, made fewer changes, made fewer final errors and had more of their changes devoted to error corrections. Wheels also sent fewer message units. Both networks became more efficient over trials in terms of message units, time and changes. Wheel groups, however, became more efficient more quickly in reducing the times taken to solve problems. Leadership was not agreed upon or recognized at all in the Circles. It was, however, almost completely present in Wheels. Differences between Wheels and Circles were not significant for the variables of satisfaction with job, satisfaction with other members and satisfaction with task. Wheels, however, were more certain of their answers than Circles. When analyses were made according to positions

in nets, differences on the latter satisfaction variables were obtained. Central members of the Wheels were more satisfied than Circle members who, in turn, were more satisfied with their jobs, fellow members and their task than peripheral members of the Wheels. Central members were more certain of their answers than peripheral members, who were more certain than Circle subjects. Wheel groups, at the end of about twenty trials, developed stable, role-differentiated divisions of labor. Circles used on nearly all occasions an each-to-all problem-solving system, with little or no role-differentiation.

The major question of this study is: do the results enable us to speak with more certainty and precision about the behaviors of problem-solving groups in different communication networks when they have been working continuously for relatively long periods of time on routine tasks?

The results of network studies of shorter duration are in general substantiated: Circle groups had higher overall satisfactions, less frequent emergence and recognition of leadership, longer time scores and more errors than Wheel groups.

Overall, the most interesting outcome of this study is the one that reveals that groups of college subjects continued to learn, regardless of the kind of network in which they worked, for periods considerably longer than the results of short term studies would have led us to expect. In particular, the times taken to solve problems and number of message units used in the problem-solving indicate clearly and consistently that groups in both Wheel and Circle nets continued to learn up to about thirty trials, after which stabilization of these measures occurred.

Analyses of information and answer exchanges in the more restricted participation condition of the Wheel indicated that stabilization of

information and answer exchanges occurred somewhat earlier than the stabilization of times taken to solve problems and number of message units. The Circle groups, which had less restriction of participation than Wheels, typically began with and continued to use a kind of organization in which each member of a group had the same role as any other: the sending out of his own information and the collection of information of others followed by each person deciding on his own answer separately. Groups in both networks continued to become more efficient, that is, took less time to solve problems, sent fewer messages and made fewer changes for a great part of their problem-solving lives.

Groups in both networks appeared to show two different kinds of learning. One kind was involved in the development of a particular kind of organization, i.e. an information and answer exchange system for meeting the requirements of the task as the participants perceived them. The other kind of learning involved increasingly more efficient usage of the organizations that were developed. For example, in the Wheel groups, the most efficient kind of organization of answer and information exchanges was developed by the fourth trial block (trial twenty): an organization in which no channels were used intermittently, four channels were used always in one direction and four channels were never used. This system meant that the peripheral members of the Wheels sent information to the central member who sent answers back to them. Groups, however, continued to show decreases in times taken to solve problems and sent fewer message units at the same time. Similarly, groups in the Circle condition continued to show decreases in time and message unit scores after their information exchange patterns had stabilized.

Thus far, two general points have been made: (a) learning continues

to take place in both communication nets longer than expected and (b) the learning that occurred was of two major kinds - that represented by the development of a division of labor in the form of stable answer and information exchanges, and the learning represented by progressively more efficient operations within such divisions. Even after the development of a division of labor, groups continued to learn how to operate more efficiently.

The rate of learning in the Wheel groups was faster than that of the Circles with respect to times taken to solve problems. The explanation of such differential learning rates is not simple. It has already been mentioned that Wheels adopted the best division of labor from among those possible within its structure, for the task at hand. Circles did not. Furthermore, Wheels stabilized their division earlier, i.e. eliminated unnecessary channels completely from usage, and developed stable answer exchanges earlier than Circles. It is reasonable to assume, other things being equal, that once members of a problem-solving group have adopted a division of labor and have stably used it, they can proceed to concentrate their efforts in the direction of using such a division of labor most efficiently. Then, if two kinds of networks lead to different divisions of labor developing at different time points, such networks will be expected to differ in the rate of learning to peak efficiency within the arrangements that they had adopted. This appears to have been the case for Wheels versus Circles, where the rate of learning of the former was greater.

Also, as part of the total explanation for the different rates of learning, we are suggesting that the early development of a hierarchical organization within the Wheel limits led to more rapid increases in efficiency through the greater existence of clearly recognized and accepted

leadership. Statistical analyses revealed such differences between the Wheels and the Circles. Since this is the case, then members in the condition with greater leadership present (the Wheel) would have been more likely to accept influence attempts by another: suggested answers, recommendations for behaving in certain ways and so on. The more the leadership is recognized, the less energy and time will be spent by members of work groups in duplicating the functions of the leader in such situations: figuring out the answers for themselves, checking on the information of others (once the leader had approved it by passing it along), and trying to set up variations in problem-solving procedures according to their own evaluations of the situation.

The surrender of such prerogatives that accompany leadership in problem-solving situations of this kind leads to a condition in which non-leader members can now devote their time and effort to doing their particular jobs better and more quickly. It can be seen that the same amount of effort devoted to fewer different kinds of activities would lead to greater efficiency, ceteris paribus, than if the effort were to be devoted to a greater number of activities and different responsibilities.

Theoretically, Wheel and Circle groups of five men each can be as productive as each other. That is, in each pattern, if things were to operate optimally, members in each condition could solve problems using only eight message units (1). Assuming similar message sending rates, the times taken to solve problems would not be significantly different. This research, as well as others, has demonstrated that the Wheels do reach this point of optimal efficiency. Circles do not.

Two major points stand out so far in helping us to understand and

account for the differences between the performances of groups in relatively long term situations within different networks: (A) networks differ in the extent to and frequency with which maximum efficiency is reached, and (B) networks vary in the extent to which they allow members to devote their energies to increasing their efficiency within the systems that develop, and in so doing, increasing the speed of optimal development.

In fact, it has been demonstrated that groups in problem-solving situations working within communication networks, continue to show changes in their behaviors long after the results of previous short-term research have indicated. Such extended learning of groups in conditions of continued practice has some important implications for the study of small groups and larger organizations.

Studying groups for relatively short terms has the potential hazard of leading to premature estimates of stabilization of performance and inferences from it about learning. Let us assume that groups in problem-solving situations show changes in performance over  $T$  number of trials, where  $T$  represents a number (of trials) less than that determined empirically to be the point of stabilization. Let us further assume that as groups continue to work after this point  $T$ , the differences between trials become smaller. If this is the case, then the following misleading situation can develop: using  $T$  trials means that those trials whose scores are most different from each other (trials before stabilization) will be used in the analyses. Let us now assume since trials after  $T$  are less different from each other than those before  $T$ , that by not including trials after  $T$ , means that the variance estimate of trials up to  $T$  will be greater. If this is the case, then greater differences between trials up to  $T$  will be required before such



differences will be considered significant. This condition means that learning of only a more gross nature will be detected. Learning will be spuriously considered to have leveled off, at earlier points, than are actually the case. To compensate for this, attention needs to be paid to overlearning in groups. Groups need to be run and members "trained" until enough of the production curve is obtained to ensure that data from further trials will not change the relationships between trial scores already obtained.

The analysis of the questionnaire data pointed out the dangers of considering such variables as satisfaction, certainty, etc, as group variables when there is role differentiation within the group. The central members of the Wheel were significantly different from the peripheral members of the Wheel on all four satisfaction variables. Hence, a statement that the Wheel group is more, or less, satisfied than a Circle group does not have as much meaning as does talking about the satisfactions of the people in different positions or having different roles within the group.

What are the contributing factors to the satisfactions of the persons occupying different positions or different roles? The order of most to least satisfied is perfectly correlated with the kind of job one does in the group. The central person's job in the Wheel consisted of receiving information, deciding on an answer and sending the answers to the other members of the group. The members of the Circle groups sent and received information and in general decided on their own answers. The central people were more satisfied than the people in the Circle groups and they were more satisfied than the peripheral members of the Wheel groups. Hence, the actual job performed was perfectly correlated with position in the network.

The question of whether satisfaction is related to position in the communication net, or job performed, or whether it is related to an interaction of the two cannot be answered here. Whether the job that is performed is always perfectly correlated with position in the communication net is a question open for further research.

## Study II

### The Effects of Changes in Communication Patterns on the Behaviors of Problem-solving Groups

This investigation was intended to provide an account of the changes in the behaviors of problem-solving groups that take place when their communication patterns are altered. Two communication patterns were used - Wheel and Circle (see Study I for an explanation of these patterns).

Ten groups of five men each were run in each of four experimental conditions: (a) Circle-to-Wheel (CW), in which groups had to solve thirty problems in the Circle pattern and then thirty more in the Wheel, (b) Wheel-to-Circle (WC), in which groups had to solve thirty problems in the Wheel and then thirty more in the Circle, (c) Circle-to-Circle (CC), in which groups had to solve sixty problems in the Circle pattern, and (d) Wheel-to-Wheel (WW), in which groups had to solve sixty problems in the Wheel pattern. These conditions enabled us to study how problem-solving groups behaved when they were changed from a condition of greater to one of less hierarchy and restriction, and vice versa, as compared to the behaviors of groups which had not experienced changes in patterns. Changes were introduced after thirty trials, on the basis of the results of Study I. Measures were taken throughout of: (1) times taken to solve problems, (2) number of

problems correctly solved, (3) leadership, (4) satisfactions - interpersonal, task and job, and (5) developments of problem-solving systems (organizations).

Three alternative assumptions about the effects of change were tested. They represented three modal ways of thinking about the effects of change, since there was neither an adequate theory nor an empirical base for predicting with certainty any single set of events: (1) It is the structure of the present work environment, not the past nor the change itself, that is the important condition affecting behavior. According to this assumption, it was expected that groups in the same present kind of communication pattern would not behave differently from each other regardless of the differences in their antecedent conditions; (2) Change in and of itself leads to improved problem-solving behaviors. According to this assumption, it was expected that the behaviors of groups in a given kind of communication pattern which has been changed from a distinct other kind would be better (qualitatively and quantitatively) than the behaviors of groups in the same given kind of communication pattern throughout; and (3) Past work conditions differentially affect behaviors in present ones. According to this third assumption, the behaviors of groups in a given communication pattern which has been changed from another kind would resemble the behaviors of the antecedent condition in the following way - the better the quality and quantity of the behaviors of the antecedent condition, the better would be the quality and quantity of the consequent one.

In general, under no-change conditions, for problems that are routine and repetitive, the communication pattern that allows for more nearly equal participation by group members results in greater overall satisfactions, less emergence and recognition of leadership, longer time scores, and a

greater amount of errors than a communication network which imposes unequal restriction of communication opportunities. This contrast was especially appropriate for Wheels versus Circles.

Overall, the results of times taken to solve problems and number of problems correctly solved provided support for the third assumption: past work conditions differentially affect behaviors in present ones. Circles that were changed from Wheels took significantly shorter times and had more correct trials than Circles that were always Circles. Wheels that were changed from Circles took significantly longer times to solve problems than Wheels that were always Wheels, but did not have significantly fewer correct trials. This inconsistency, on the surface, might seem to weaken the inference that assumption three is supported, and even partly justify the inference that assumption two is supported: change in and of itself leads to improvement. However, when the results of analyses of organizational and satisfaction developments are reported, it will become quite clear that assumption two is unsupported. The discussion that follows reports in greater detail the evidence supporting the third assumption and provides explanations for the events that occurred in this study.

The systematic differences that were found between groups in the same communication patterns but which had had different work experiences resulted from organizational developments which were the products of the efforts of participants to apply what they had learned in previous nets, to select the most efficient methods of work and to reduce the ambiguity of new work environments.

The organizing responses of groups to new networks were influenced by their organizational experiences in previous networks. Training was transferred. The more the new conditions permitted the transfer, the greater it was. Circle patterns permitted greater transfer than Wheels because of their fewer restrictions. Consequently, nearly all of the Circles in the WC condition developed into Chain patterns, which were the most centralized arrangements that could possibly have emerged from within Circles. Wheels in the CW condition revealed no such development of emergent structures. Their restrictions very greatly reduced the probability of new structures emerging. In both conditions, WC and CW, performances were affected by the past. In the case of the WC condition, the development of Chains mediated the changes in behavior that occurred. In the case of the CW condition, time standards seem to have been transferred more directly, as revealed by the relative speed with which members of Wheel groups in CW used their channels.

As well as utilizing knowledge derived from experiences in previous networks, groups behaved rationally. When they were confronted with changed patterns of communication from which more than one problem-solving system could have emerged, they selected the kind of pattern most similar to the one with which they had had experience. For example, in the WC condition, when changes were made from W to C, participants were initially required by the novelty of the situation to review the whole work structure, i.e. who-could-do-what-to-whom. Opportunity was immediately available to them to develop their work patterns from a number of possible ones. The problem-solving system that emerges from within the Circle pattern under normal conditions (without the antecedent condition of the Wheel) is an "each-to-all"

system. This later came to be incompletely developed and rejected. Groups progressively became more efficient as Chains. They eliminated unnecessary channels and used the other channels in specific ways, thus leading to the development of specialization of roles. Groups apparently responded to problem-solving cues (longer times and greater answer-uncertainty) that revealed the inadequacy of the "each-to-all" system. Such cues stemmed from the comparative efficiency (shorter times and greater answer-certainty) of the former Wheel arrangements in which they had worked. The only way such groups could have developed most effectively within their operating limits was to have continuously selected from the channels those alternatives available at each trial which least hampered the development of systems that approximated the previous Wheel patterns. The explanation of rationality in their problem-solving behavior is further supported when it is realized that, in order for those WC groups to develop into Chains, which are the most efficient patterns that develop from within Circles for this kind of task, they had to impose severe operating restrictions on themselves.

Groups in all conditions developed stable problem-solving systems for reducing the ambiguity that accompanied the changes to new networks. Quite obviously, the most important steps that the groups had to and did follow in order to reduce ambiguity were: (a) familiarizing themselves with the changed conditions, (b) assessing the nature of the new conditions for the problems facing them, and (c) deciding upon some system for coping with the problems.

The Circle groups that developed most efficiently (into Chains) differed from those that did not (WC versus CC) in steps (b) and (c). That is, the Circles that came from Wheels attempted to reduce ambiguity by spending more

of their effort on understanding their structures and developing hierarchical systems for coping with the problems. The CC groups reduced the ambiguity of the new conditions by immediately adopting and continuing to use all channels, in a systematic "shot-gun" fashion.

The effects of changes in communication patterns on the satisfactions of groups in them were considerably different from those involving productivity (time taken to solve problems and number of correct trials). It seemed quite clear that the same suggested explanations of organization that might be used to account for the effects of changes on performances were inadequate for incorporating the results of satisfactions.

That the performances and satisfactions of members of problem-solving groups may be differently affected by the work environment (and changes in it) is a conclusion arrived at by numerous researchers. Satisfactions, in different studies, have been reported as positively related (5,6), unrelated (7,8) and even negatively related (2,9) to performance.

Except for the variable of satisfaction with job, in which no significant differences were found, the Circles that were changed from Wheels were more satisfied with their fellow members, more interested in the task, and more certain of their answers than were groups in the CC condition. Chain groups are generally less satisfied than Circle groups (1, 10, 12). Yet, in spite of the fact that eight of the ten WC groups developed into Chains and none of the CC groups did, the WC groups were significantly more satisfied in the variables that were mentioned. This is unexpected, since in nearly all research on communication networks, the satisfactions that groups experience under different communication conditions are considered to be directly dependent upon the opportunities to participate in decision-

making. The Chains which emerged in the WC condition restricted opportunities to communicate to others and to share in the decision-making more than the Circles that were Circles throughout. Yet, these WC groups were significantly more satisfied overall. In the same context, Wheels that came from Circles were significantly less satisfied with their jobs and less certain of their answers than were Wheels that were always Wheels. Predicting on the basis of structure alone, it would have been expected that satisfactions in both the WW and CW groups would not have been significantly different from each other, since the problem-solving systems used in both conditions were the same. Predicting on the basis of the organizational explanations (assumption three extended to satisfactions) given for differences in times and number of correct trials, it would have been expected that Wheels that came from Circles would have been significantly more satisfied than WW groups. Together, these latter explanations suggested that groups in a changed situation not only would take on the organizational characteristics of the previous patterns as nearly as possible, but would also show greater similarities in satisfactions. Performance results supported such expectations, but satisfaction scores in no case did. In most cases they supported the reverse predictions. To account for such satisfaction results, two additional explanations need to be invoked.

The satisfactions that people experience in situations with specific degrees of restrictions depend on the contrast with the degree of restrictions experienced in previous situations. The size and the direction of the differences in restrictions and the positions of people in such past conditions influence the level of satisfactions of members in new situations. This is somewhat similar to applying a principle of "relative deprivation" (11) to the



satisfactions experienced by members of problem-solving groups when going from one set of restrictions to another. The concept as originally used (13) and as refined (11) help to explain differences in attitudes that people have toward their life situations on the basis of the groups used as reference points for evaluating one's lot in life. Knowledge, or at least beliefs about the conditions of others, was necessary for deprivation to have been relative. In this experiment on change, knowledge about the conditions of others was not available.. Neither was there opportunity for strong belief systems to have developed about the restrictions that other groups experienced. The deprivation was relative, however, to the previous work conditions that members themselves had experienced. Deprivation was relative, therefore, to the kinds of changes that took place in their own working conditions.

Members of the Circles that came from Wheels, even though they developed the most restricted and centralized network from among those possible in the Circle network, nevertheless felt more satisfied with other members, more interested in the task and more certain of their answers than did Circles which were always Circles and which never developed into Chains with the accompanying greater restrictions on behavior. Relative deprivation applies in that the WC groups came from the most structured (restricted) condition of the Wheel, in which four of the five members occupied peripheral positions and in which neither the positions nor the structure of the Wheel were established by the members themselves.

When the pattern of the Wheel was opened to the Circle, the members elected, and election is the crucial factor here, a Chain structure, and in so doing, imposed greater communication restriction on themselves than was dictated by the channel availabilities of the Circle network. Furthermore,

only two of the five positions were peripheral in the Chain, i.e. only two positions were Ends. Of the remaining three positions, one was a Center position and two were Relay positions. In view of the above, it would be reasonable to have expected that change from a condition of greater to less restriction would lead to greater satisfactions than under the condition of less restriction throughout.

Changes involving increase of restriction (Circles to Wheels) would be expected to show significant decreases in satisfactions. Changes involving decrease in restrictions would be expected to show significant increases in satisfactions. Both expectations were confirmed for all satisfaction variables. In addition, groups seemed to have experienced more depression (lower satisfaction scores) under conditions of increased restrictions than they felt uplifted at having restrictions decreased. Apparently, the harmful effects on morale when decision-making opportunities are reduced are greater than the positive effects when decision-making opportunities are increased. As an explanation of this result, we need again to consider the concept of relative deprivation, but in a broader context this time. All of the participants were American males, reared in a culture in which equality is stressed and in which upward mobility is strongly ingrained. Americans, most of us generally, resist classifying ourselves as doing less important and less worthwhile jobs than others. Such resistance might be expected to be especially prominent in the case of college students doing relatively simple tasks. Imposed differences in positions and the accompanying differences in status and evaluation of one's contribution would lead to low satisfactions. A change from a more restricted to a less restricted condition, while it would be welcomed in the light of the reasons given above, would be more in

keeping with the expectations that our participants probably had about the jobs that they should have had. An opposite, but disproportionately greater, effect would be brought about by the change from a less restricted to a more restricted condition, since notions of equality had been reinforced by the pre-change problem-solving condition of the Circle network. Both relative deprivation and self-establishment of restrictions were suggested as additional explanations for the satisfaction results. However, the results reported thus far do not answer the question of whether distinctions can be made between the effects of relative deprivation and those of self-establishment of restrictions.

As part of the third study in this research series, a report is being prepared which includes the results of tests for possible distinctions. By comparing the two WC groups that remained as Circles with the groups that were always Circles, it is possible to tentatively answer the question of whether relative deprivation makes a significant difference when self-establishment versus non-self-establishment is a controlled variable, and when the problem-solving systems that were used remained the same. If relative deprivation has a significant positive effect on satisfactions in addition to the effect of self-establishment of restrictions alone or in interaction with it, then it would be expected that the two WC groups would be significantly more satisfied than the CC groups. To answer the question of whether or not the variable of self-establishment versus non-self-establishment of restrictions can be used to distinguish between groups which have been equally relatively deprived and which used the same kind of problem-solving system, would require comparisons between the eight WC groups that developed into Chains and Chain groups which were imposed as Chains, after having been

antedeceded by Wheels. There are no data to answer this question.

The results point out some factors that might be significantly related to the problem of continuity of leadership in organizations. It was found that not only did eight of the ten WC groups develop into Chains, but also, of the eight emergent Chains, only one maintained the former leader of the Wheel arrangement (central position) as Center man in the new communication arrangement. There was obviously a significant relocation of leadership. In five of the eight cases, former leaders were relegated to positions as End-men and two to positions as Relay-men. In particular, however, the question of what might account for the very apparent discontinuity in leadership is raised. One possible explanation might be that in the new conditions the more capable and better naturally qualified people became leaders. Yet, in the initial assignment of men to the central positions the procedure was a completely random one, so that even on the basis of chance, we might have expected more than one of the eight leaders in the new situation to have been naturally more capable in the original conditions. This explanation is inadequate, especially when we consider the kinds of work conditions characterizing pre and post-change situations. The pre-condition of the wheel was a completely imposed one. The members of the Wheel groups had no opportunity to select the leader (the person who was to occupy the central position). From the very beginning, they were required to communicate in rigidly defined ways to the imposed leader. When the patterns were changed from Wheels to Circles, what seemed to have happened was that members were now placed in conditions of less restriction. In particular, there now existed opportunities to establish their own leadership electively, as well as to develop their own kind of division of labor. Possibly, in reaction

against the imposition of leadership and organization in the antecedent Wheel condition, members rebelled and relocated the former leader to positions of less and often of least importance. It has been found (4) that leaders are less likely to continue in such roles under conditions of changes in work environment when they originally were met with disagreement in the early stages of their leadership. It has also been found (3) that leaders tend to be replaced under crisis conditions, when guidelines for coping with environmental demands are no longer adequate and when the former leaders are unable to offer adequate substitute guidance. In our research, there are some conditions similar to those mentioned above. As in the former investigation, the initial condition of leadership was one of imposition. Members, for reasons previously mentioned, might not have been too happy with this as well as with the rather severe restrictions and unequal participation opportunities. In addition, the former leaders were unable to alter the communication limits of the new patterns. They themselves were limited by the communication opportunities available to them. Interestingly enough, even though the WC groups had experienced such initial restrictions of leadership and organization, they still developed the most restricted arrangement possible within the new Circles - the Chain. The explanation may lie in the fact that the members in the new condition had the opportunity to impose the restrictions on themselves.

There are several organizational implications that might be drawn from such explanations: (1) Leadership continuity under conditions of changes in work environments depends on the way in which the antecedent position of leadership came to be fulfilled; by election or imposition, with initial acceptance by members or with disagreement. (2) In situations of change,

from very restricted to less restricted conditions, people will develop, on their own, structured and restricted conditions of work, provided such conditions appear to be best for solving the problems at hand and provided that the restrictions involved are self-imposed. (3) When communication conditions are being established for the production of any good, attention should be paid to the probability of actually attaining the maximally efficient systems within such conditions. The theoretical properties of problem-solving arrangements, such as communication networks, need to be considered therefore, not only in terms of the ultimate limits they place on the behaviors of members, but also in terms of the actual operating restrictions that are likely to come about as the result of such theoretical limits: the kind of information and answer exchange systems likely to develop. To give an illustration of this taken from our research: Wheel patterns, which have been shown to lead to more efficient performances than Circles in such problem-solving situations, with rare exception develop the kind of organization in which members follow the communication restrictions exactly, so that four members send information to and receive answers from the fifth or central person. It is rare (significantly so) that other possible patterns emerge and are adopted consistently. Similarly, for Circle patterns (when there has been no change) members typically adopt an "each-to-all" problem-solving arrangement using nearly all of the channels all the time for distributing information for answer formation. However, the Circle theoretically allows for a number of other kinds of arrangements to develop. Among them is the Chain. For Circles (as well as for Wheels and any other networks) it is possible to empirically order the different kinds of information and answer exchange systems that can possibly develop

within such structures according to the likelihood of such systems actually occurring under such arrangements.

Normally then, we have a case in which Circles allow for the emergence of certain problem-solving systems in a knowable rank-order. The most probable arrangement to emerge is the "each-to-all" type. However, when there has been an antecedent condition of Wheel, what happens is that the most probable arrangement to emerge becomes the Chain. In effect, what has happened is that the antecedent condition of Wheel, when the change was to Circle, led to changes in the probabilities of occurrence of the possible systems within the Circle. Chain information and answer exchange systems became the ones most likely to emerge, rather than the "each-to-all" kind of ordinary Circle.

It is rare in practice that the activities of members of problem-solving groups are so programmed within a work structure that there is no more than one system possible for reaching established goals. The results of this research strongly suggest that there is a hitherto relatively unemphasized and unexplored important influence of past organizational experiences on the methods adopted by members of work groups to achieve their goals. With more knowledge about the principles of organization that govern the regulating effects of the past, uncertainty in organizational planning can be considerably reduced. This is especially important when planned program changes are involved.

There are two articles in progress, in addition to Studies I and II. The first of these additional reports, Study III, contains the results of analyses of the effects of changes on the individuals occupying different positions in the original and emergent problem-solving arrangements. Questions about the effects of promotion and demotion on satisfactions, about the organizational factors involved in the emergence of leadership, as well as others, are being answered. The second of these reports, Study IV, is a theoretical article which expresses in a general form the empirical results of Studies I and II, with major emphasis on Study II. In this paper, additional propositions about the effects of changes in communication patterns are derived, and extensions are made to other and more extreme change situations, in which the effects of changes are predicted from the general form. Two additional studies are being conducted. The first, Study V, is an experimental test of some of the major predictions made from the general form developed in Study IV. The second, Study VI, is a test of an hypothesis derived from Study II, which suggests, briefly, that leadership continuity under conditions of organizational change is positively related to opportunity to choose or replace leadership in the initial conditions.



## References

1. Bavelas, A., "Communication Patterns in Task-oriented Groups," Journal of the Acoustical Society of America, 1950, 22, 725-730.
2. Habbe, S., "Job Attitudes of Life Insurance Agents," Journal of Applied Psychology, 1947, 31, 111-128.
3. Hamblin, R.L., "Leadership and Crises," Sociometry, 1953, 21, 322-335.
4. Katz, E., P. Blau, M. Brown, and F. Strodbeck, "Leadership Stability and Social Change: An Experiment with Small Groups," Sociometry, 1957, 20, 36-50.
5. Katz, D. and H. Hyman, "Industrial Morale and Public Opinion Methods," International Journal of Opinion and Attitude Research, 1947, 1, 13-30.
6. Katz, D. and H. Hyman, "Morale in War Industry," in T.M. Newcomb and E.L. Hartley (Editors), Readings in Social Psychology, New York: Holt and Company, 1947, 437-447.
7. Katz, D., N. Maccoby, and N. Morse, "Productivity, Supervision and Morale in an Office Situation," University of Michigan Survey Research Center, 1950.
8. Katz, D., N. Maccoby, G. Gurin, and L.G. Floor, "Productivity, Supervision and Morale Among Railroad Workers," University of Michigan Survey Research Center, 1951.
9. Kornhauser, A., and A. Sharp, "Employee Attitudes: Suggestions from a Study in a Factory," Personnel Journal, 1932, 10, 393-401.
10. Leavitt, H.J., "Some Effects of Certain Communication Patterns on Group Performance," Journal of Abnormal and Social Psychology, 1951, 46, 38-50.
11. Merton, R.K., "The Unanticipated Consequences of Purposive Social Action," American Sociological Review, 1936, 1, 894-904.
12. Shaw, M., "Group Structure and the Behavior of Individuals in Small Groups," Journal of Psychology, 1954, 38, 139-149.
13. Stouffer, S.A., E.A. Suchman, L.C. DeViney, S.A. Star, and R.M. Williams, Jr., The American Soldier, Vol. I, Princeton, N.J.: Princeton University Press, 1949.